I claim:

1. An alkali vapor optical amplifier, comprising:

a gain medium comprising a mixture of at least one buffer gas and an alkali atomic vapor having a D_1 transition, wherein said at least one buffer gas has the dual purpose of collisionally broadening a D_2 transition of said alkali atomic vapor and collisionally transferring pump excitation from the upper level of said D_2 transition to the upper level of said D_1 transition at a rate larger than the radiative decay rate of either of these two levels; and

a pump laser emitting pump radiation at a wavelength $\lambda(D_2)$ with an emission spectral width within the range from 1-6 nm (FWHM), for optically pumping said gain medium at a wavelength of said D_2 transition, including optically pumping in the Lorentzian spectral wings of said D_2 transition, wherein laser light at wavelength $\lambda(D_1)$ operatively passed through said gain medium will be amplified at a wavelength of said D_1 transition.

2. The alkali vapor optical amplifier of claim 1, wherein said pump laser comprises at least one semiconductor diode laser emitting at said wavelength $\lambda(D_2)$.

3. The alkali vapor optical amplifier of claim 1, further comprising an optical cell through which said mixture flows or is contained.

4. The alkali vapor optical amplifier of claim 1, wherein said alkali vapor is selected from the group consisting of cesium (Cs), rubidium (Rb), potassium (K), sodium (Na), and lithium (Li).

5. The alkali vapor optical amplifier of claim 1, wherein said at least one buffer gas is selected from the group consisting of rare gases and light molecular gases.

6. The alkali vapor optical amplifier of claim 5, wherein said rare gases are selected from the group consisting of xenon, krypton, argon, neon, and helium.

7. The alkali vapor optical amplifier of claim 5, wherein said light molecular gases are selected from the group consisting of hydrogen, methane, ethane, propane, and their deuterated analogues.

8. The alkali vapor optical amplifier of claim 1, wherein the alkali vapor is cesium and the buffer gases are helium and ethane.

9. The alkali vapor optical amplifier of claim 2, wherein said at least one semiconductor diode laser emits at a wavelength of ~852 nm.

10. The alkali vapor optical amplifier of claim 2, wherein said at least one semiconductor diode laser comprises material selected from the group consisting of AlGaAs, InGaAsP, and InGaAlP.

11. The alkali vapor optical amplifier of claim 1, wherein the alkali vapor is rubidium and the buffer gases are helium and ethane.

12. The alkali vapor optical amplifier of claim 2, wherein said at least one semiconductor diode laser emits at a wavelength of ~780 nm.

13. The alkali vapor optical amplifier of claim 1, wherein said alkali vapor comprises potassium and wherein said at least one buffer gas is selected from the group consisting of helium and argon.

14. The alkali vapor optical amplifier of claim 1, wherein said at least one semiconductor diode laser emits at a wavelength of ~766 nm.

15. The alkali vapor optical amplifier of claim 3, further comprising a hollow lens duct positioned to direct pump radiation from said pump laser into said optical cell.

16. A method for amplifying laser light, comprising:

pumping, with a pump laser having an emission spectral width within the range from 1-6 nm (FWHM), an alkali/buffer gas gain mixture at a wavelength $\lambda(D_2)$ of a pressure-broadened D_2 transition of an alkali atomic vapor, wherein said mixture is optically pumped well into the Lorentzian spectral wings of said D_2 transition; and

extracting spectrally narrowband radiation at a wavelength $\lambda(D_1)$ generated on a spectrally-homogeneous D_1 transition of said alkali atomic vapor, wherein said buffer gas collisionally induces a transfer of pump excitation from the upper level of said D_2 transition to the upper level of said D_1 transition at a rate larger than the radiative decay rate of either of these two levels, wherein said mixture comprises at least one buffer gas, wherein said at least one buffer gas has the dual purpose of collisionally broadening said D_2 transition and collisionally transferring pump excitation from the upper level of said D_2 transition to the upper level of said D_1 transition at a rate larger than the radiative decay rate of either of these two levels.

17. A method for converting spectrally broadband radiation from a pump semiconductor diode laser array into a high power beam with spectrally narrowband radiation, comprising the steps of:

depositing, into a defined volume of an alkali/buffer-gas gain mixture, pump radiation at a wavelength $\lambda(D_2)$ matching a wavelength of a D_2 transition of said alkali/buffer-gas gain mixture, including optical pumping in the Lorentzian spectral wings of said D_2 transition, wherein said pump radiation is provided by a

multi-spatial-mode semiconductor diode laser or laser array comprising an emission spectral width within the range from 1-6 nm (FWHM);

spatially over-lapping said volume with the volume through which a spectrally narrowband master oscillator extraction beam propagates; and

extracting power from said alkali/buffer-gas gain mixture in a spectrally narrowband, amplified MO beam at an output wavelength $\lambda(D_1)$ matching a wavelength of a D_1 transition of said alkali vapor, wherein said buffer gas collisionally induces a transfer of pump excitation from the upper level of said D_2 transition to the upper level of said D_1 transition at a rate larger than the radiative decay rate of either of these two levels, wherein said mixture comprises at least one buffer gas, wherein said at least one buffer gas has the dual purpose of collisionally broadening said D_2 transition and collisionally transferring pump excitation from the upper level of said D_2 transition to the upper level of said D_1 transition at a rate larger than the radiative decay rate of either of these two levels.

18. A method for converting the substantially-divergent, multi-spatial-mode of semiconductor diode laser array pump radiation into a near diffraction-limited coherent laser radiation, comprising the steps of:

depositing, into a defined volume of an alkali/buffer-gas gain mixture, pump radiation at a wavelength $\lambda(D_2)$ matching a wavelength of a D_2 transition of said alkali/buffer-gas gain mixture, including optical pumping in the Lorentzian spectral wings of said D_2 transition, wherein said pump radiation is provided by a

multi-spatial-mode semiconductor diode laser or laser array comprising an emission spectral width within the range from 1-6 nm (FWHM);

spatially over-lapping said volume with the volume through which the master oscillator extraction beam propagates ; and

extracting power from said alkali/buffer-gas gain mixture in the amplified MO beam at an output wavelength $\lambda(D_1)$ matching a wavelength of a D_1 transition of said alkali vapor, wherein said buffer gas collisionally induces a transfer of pump excitation from the upper level of said D_2 transition to the upper level of said D_1 transition at a rate larger than the radiative decay rate of either of these two levels, wherein said mixture comprises at least one buffer gas, wherein said at least one buffer gas has the dual purpose of collisionally broadening said D_2 transition and collisionally transferring pump excitation from the upper level of said D_2 transition to the upper level of said D_1 transition at a rate larger than the radiative decay rate of either of these two levels.